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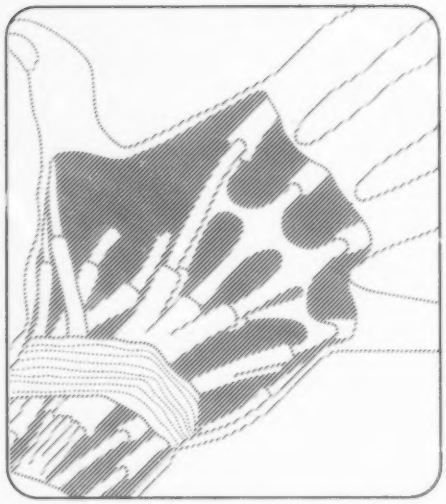

REPETITIVE MOTION INJURIES *(RMI)*

P90-21E

by
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1. WHAT ARE REPETITIVE MOTION INJURIES?

Repetitive motion injuries (RMI) are a group of painful disorders of muscles, tendons, and nerves. Carpal tunnel syndrome, tendonitis, thoracic outlet syndrome, and tension neck syndrome are examples. Work activities which are frequent and repetitive, or activities with awkward postures cause these disorders which may be painful during work or at rest.

Almost all work requires the use of the arms and hands. Therefore, most repetitive motion injuries affect the hands, wrists, elbows, neck, and shoulders. Work using the legs can lead to repetitive motion injuries of the legs, hips, ankles, and feet. Some back problems also result from repetitive activities.

2. ARE THERE OTHER NAMES FOR REPETITIVE MOTION INJURIES?

Repetitive motion injuries are very difficult to define within traditional disease classifications. These disorders have received many names, such as:

- Repetitive motion injuries
- Repetitive strain injuries
- Cumulative trauma disorders
- Occupational cervicobrachial disorders
- Overuse syndrome
- Regional musculoskeletal disorders
- Soft tissue disorders

Most of the names do not accurately describe the disorders. For example, the term the term "repetitive strain injuries" suggests that repetition causes these disorders, but awkward postures also contribute. These terms are used synonymously, and in the absence of agreement, repetitive motion injuries is used in this document.

3. HOW COMMON ARE REPETITIVE MOTION INJURIES?

Repetitive motion injuries are recognized as leading causes of significant human suffering, loss of productivity, and economic burdens on society. However, we do not have reliable estimates of the number of repetitive motion injuries in Canada. The data available are limited and do not represent the magnitude of the problem because there is a great deal of under-reporting of these types of injuries. For example, over 20,000 Ontario workers received compensation in 1987 for new cases of repetitive motion injuries, accounting for about 600,000 days of lost work. In British Columbia, over half the industrial disease claims are due to repetitive motion injuries. A survey of cashiers throughout B.C., performed by Simon Fraser University and the United Food and Commercial Workers in 1982, indicated that over 30% of the work force surveyed suffered a form of repetitive motion injury.

4. WHAT ARE THE RISK FACTORS FOR REPETITIVE MOTION INJURIES?

Work-related repetitive motion injuries arise from ordinary arm and hand movements such as bending, straightening, gripping, holding, twisting, clenching and reaching. These common movements are not particularly harmful in the ordinary activities of daily life. What makes them hazardous in work situations is the continual repetition, often in a forceful manner, and most of all, the speed of the movements and the lack of time for recovery between them.
Work-related repetitive motion injuries are associated with work patterns that include:

- Fixed or constrained body positions
- Continual repetition of movements
- Force concentrated on small parts of the body, such as the hand or wrist
- A pace of work that does not allow sufficient recovery between movements

Generally, none of these factors acts separately to cause RMI. Repetitive motion injuries commonly occur as a result of a combination and interaction among them.

Heat, cold and vibration also contribute to the development of RMI.

Body Position

There are two aspects of body position (posture) that contribute to injuries in jobs involving repetitive tasks.

The first relates to the position of the part of the body that performs the actual task, usually the upper limb. For example, tasks that require repetitive movements to the extreme ranges of the joint in the wrist, elbow or shoulder contribute to the occurrence of a painful condition in those areas. Table 1 gives examples of such movements. Poor layout of the workstation and improper selection of equipment and tools can lead to these hazardous body movements.

Table 1

Body Movement	Area of Pain
repetitive, horizontal or vertical movements of the wrist to the extreme ranges (Fig. 1a) moving fingers while the wrist is in an extreme position (Fig. 1b, 1c)	wrist and palm
repetitive bending or straightening of the elbow from its neutral position (at a right angle) twisting the wrist and forearm (Fig.2)	elbow
reaching above shoulder level (Fig. 3b) reaching behind the trunk (Fig. 3c) reaching far out in front of the body (Fig. 3a) twisting the arm (Fig. 3c)	neck and shoulder

The other postural aspect that contributes to RMI is a fixed position of the neck and the shoulders. To perform any controlled movement of an upper limb, the worker must stabilize the shoulder-neck region. Muscles in the shoulder and the neck contract and stay contracted to hold the position stable for as long as the task requires. The contracted muscles squeeze the blood vessels. This restricts the flow of blood all the way down to the working muscles of the hand where the blood, because of the intense muscular effort, is needed the most. The result is twofold. The neck/shoulder muscles become fatigued, even though there is no movement. This contributes to pain in the neck area. At the same time, the reduced blood supply to the remaining parts of the upper limb accelerates fatigue in the moving muscles, making them more susceptible to injury.

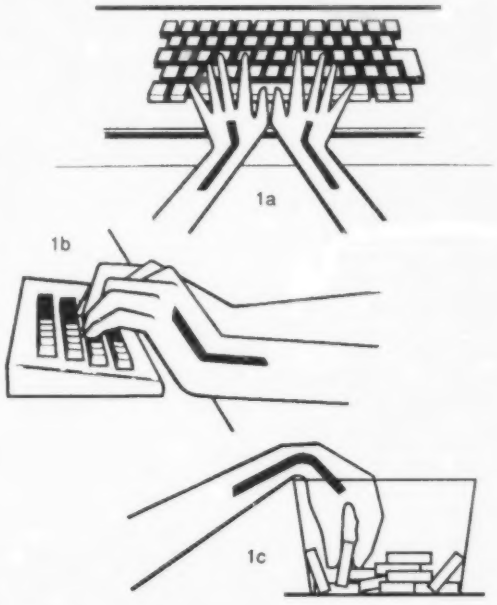


Figure 1 - **Hazardous movements of the hand**

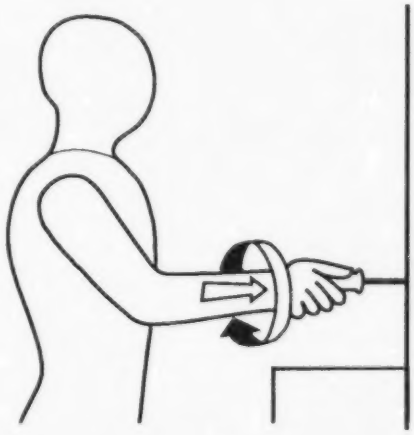
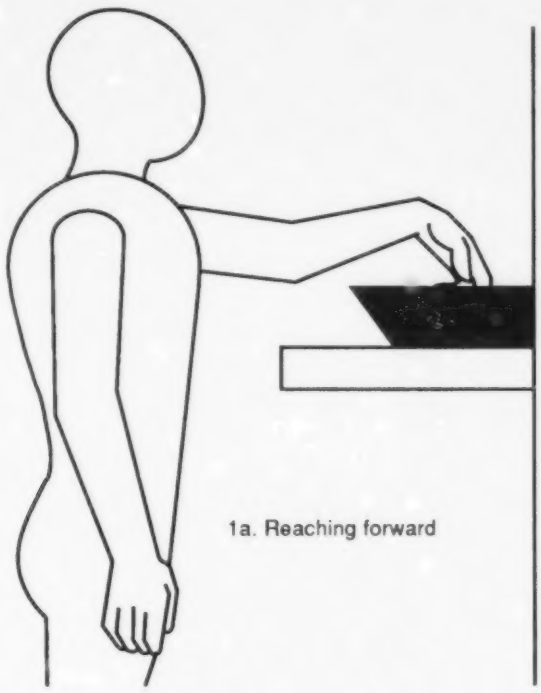
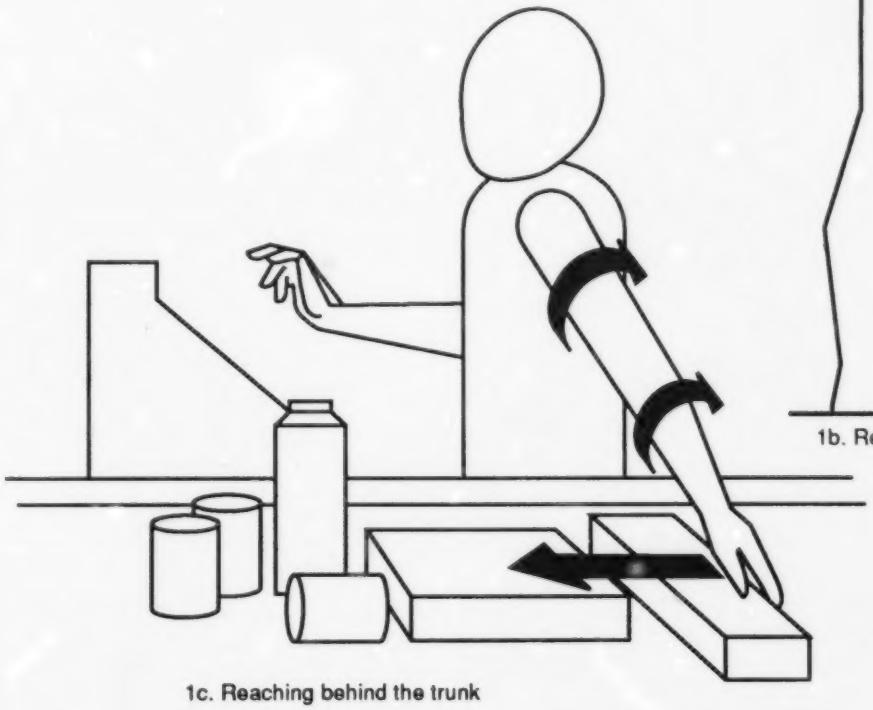


Figure 2 - **Exerting force while extending forearm**



1a. Reaching forward

1b. Reaching above shoulder level



1c. Reaching behind the trunk

Figure 3 - **Hazardous reaching movements**

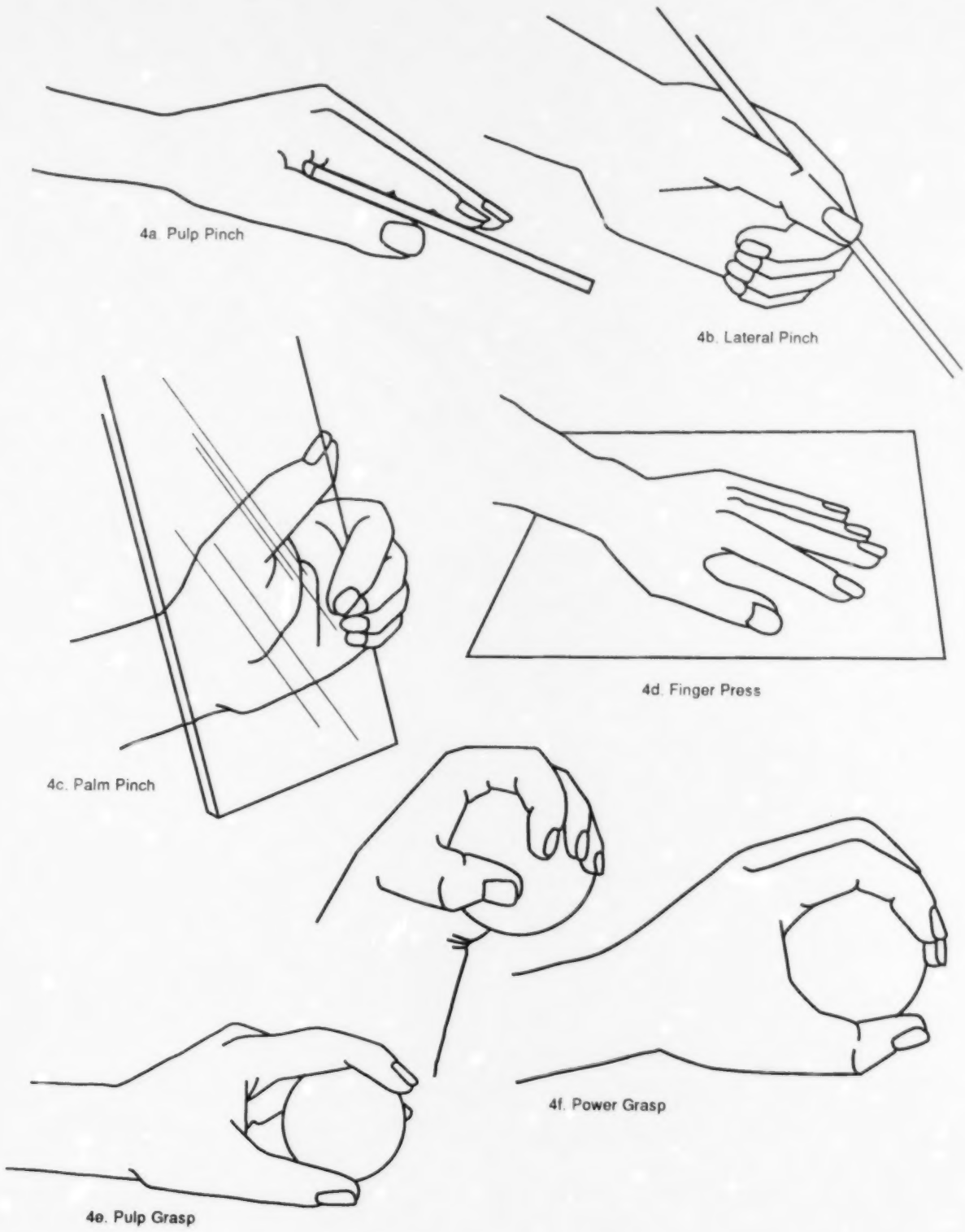


Figure 4 - **Exerting force in various hand positions**

Repetition

Workers performing highly repetitive tasks are at the highest risk for RMI. This shows that repetition of movements, although it never acts separately, is most likely the strongest risk factor. Tasks requiring repetitive movements always involve other risk factors for RMI such as fixed body position and force: the worker, in order to perform the task, has to maintain the shoulder and neck in a fixed position and to exert some force.

Work involving movement repeated over and over again is very tiring. This is because the worker cannot fully recover in the short periods of time that are given between tasks. With time, the effort to maintain the repetitive movements, even if they involve minimal forces, steadily increases. When the work activity is continued in spite of the developing fatigue, injuries occur.

Force

The force required to do the task also plays an important role in the onset of RMI. More force equals more muscular effort, and consequently, a longer time is needed to recover between tasks. Since in repetitive work, as a rule, there is not sufficient time for recovery, the more forceful movements develop fatigue much faster. Exerting force in certain hand positions is particularly hazardous (Fig. 4). The amount of force needed depends on the weight of the tools and objects that the worker is required to operate or move, and their placement in relation to the worker's body. More strength has to be used the farther away from the body the force has be be applied. The shape of the tool plays an important role, also. Tools that do not allow the best position of the wrist, elbow and shoulder substantially increase the force required. Worn and poorly maintained tools are very important as well, yet often overlooked. For example, a worn screwdriver, pliers with worn jaws, or dull scissors can increase the operating force as much as tenfold.

Pace of Work

Pace of work determines the amount of time available for rest and recovery of the body between cycles of a particular task. The faster the pace, the less time is available and the higher the risk for RMI.

When the worker has no control over timing and speed of work because of external factors like assembly line speed or quota systems then stress level increases. With higher stress level comes muscle tension causing fatigue and again increased risk for RMI. Controlling the pace of work externally denies the worker the flexibility to determine their own work speed. It is a human characteristic to work at varying rates at different times of the day.

Temperature and Vibration

Temperature and humidity affect the worker performing repetitive work. When it is too hot and too humid, the workers tire more quickly and thereby become more susceptible to injury. On the other hand, cold temperatures decrease the flexibility of muscles and joints, increasing the likelihood of injury of any kind.

Vibration affects tendons, muscles, joints, and nerves. Workers using vibrating tools may experience numbness of the fingers, loss of touch and grip, and pain. For more information on this subject, refer to the CCOHS publication Raynaud's Phenomenon (P89-13E).

5. HOW DO REPETITIVE MOTION INJURIES OCCUR?

Repetitive motion injuries do not happen as a result of a single accident or injury. Rather, they develop gradually as a result of repeated trauma. Excessive stretching of muscles and tendons can cause injuries that only last a short time. But repeated episodes of stretching causing tissue inflammation can lead to long-lasting injury or repetitive motion injuries. Repetitive motion injuries include three types of injuries:

- muscle injury
- tendon injury
- nerve injury

Muscle Injury

When muscles contract, they use chemical energy from sugars and produce by-products such as lactic acid which are removed by the blood. A muscle contraction that lasts a long time reduces the blood flow. Consequently, the substances produced by the muscles are not removed fast enough, and they accumulate. The accumulation of these substances irritates muscles and causes pain. The severity of the pain depends on

the duration of the muscle contractions and the amount of time between activities for the muscles to get rid of those irritating substances.

Tendon Injury

Tendons consist of numerous bundles of fibres that attach muscles to bones. Tendon disorders related to repetitive or frequent work activities and awkward postures occur in two major categories — tendons with sheaths (Fig. 5), found mainly in the hand and wrist; and tendons without sheaths (Fig. 6), generally found around the shoulder, elbow, and forearm.

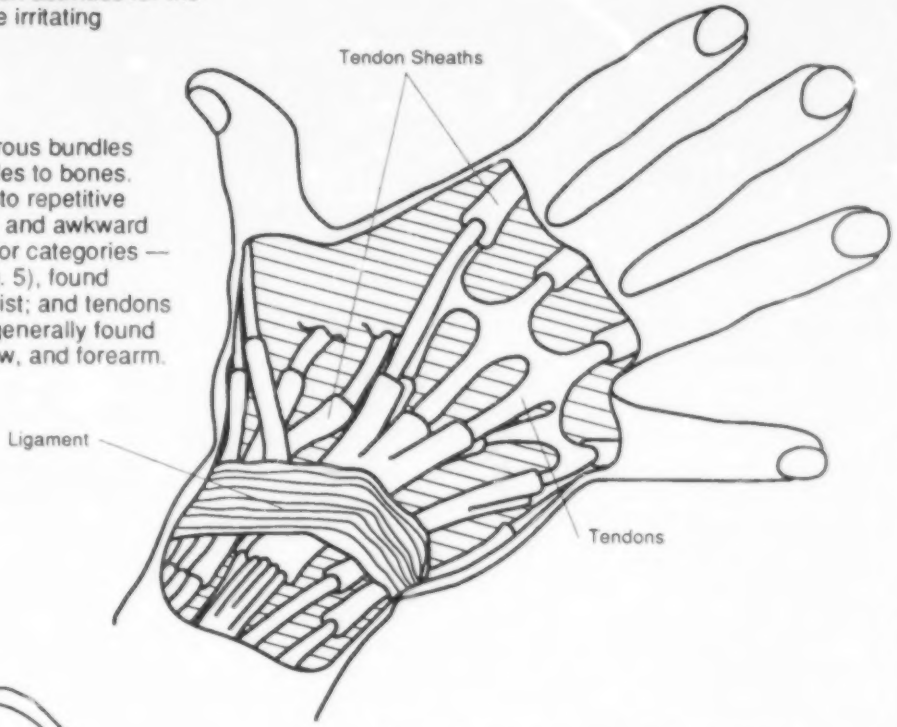


Figure 5 - **Finger tendons and their sheaths**

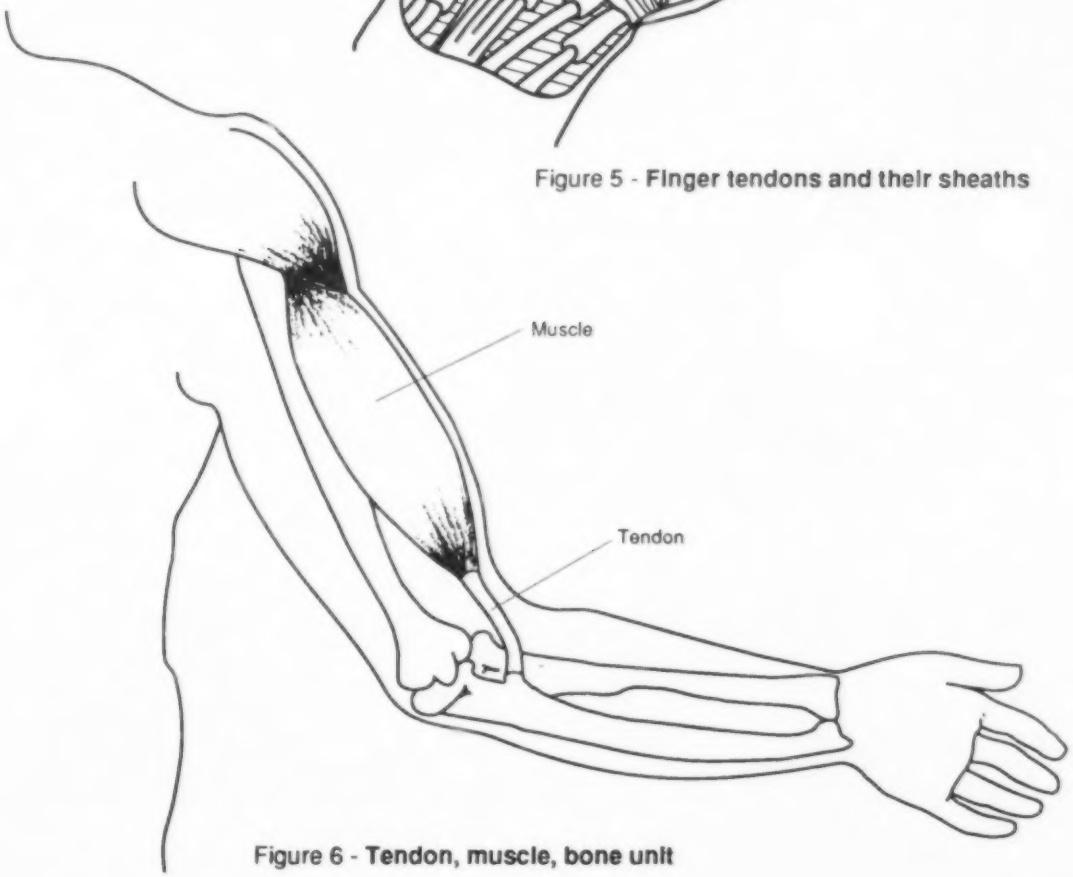


Figure 6 - **Tendon, muscle, bone unit**

The tendons of the hand are encased in sheaths through which the tendon slides.

The inner walls of the sheaths contain cells that produce a slippery fluid to lubricate the tendon. With repetitive or excessive movement of the hand, the lubrication system may malfunction. It may not produce enough fluid, or it may produce a fluid with poor lubricating qualities. Failure of the lubricating system creates friction between the tendon and its sheath, causing inflammation and swelling of the tendon area. Repeated episodes of inflammation cause fibrous tissue to form. The fibrous tissue thickens the tendon sheath, and hinders tendon movement. Inflammation of the tendon sheath is known as tenosynovitis. When inflamed, a tendon sheath may swell up with lubricating fluid and cause a bump under the skin. This is referred to as a ganglion cyst.

Tendons without sheaths are vulnerable to repetitive motions and awkward postures. In fact, when a tendon is repeatedly tensed, some of its fibres can tear apart. The tendon becomes thickened and bumpy, causing inflammation. Tendonitis is the general term indicating inflammation of the tendon. In some cases, such as in the shoulder, tendons pass through a narrow space between bones. A sac called the bursa filled with lubricating fluid is inserted between the tendons and the bones as an anti-friction device. As the tendons become increasingly thickened and bumpy, the bursa is subject to a lot of friction and becomes inflamed. Inflammation of the bursa is known as bursitis.

Nerve Injury

Nerves carry signals from the brain to control activities of muscles. They also carry information about temperature, pain and touch from the body to the brain, and control bodily functions such as sweating and salivation. Nerves are surrounded by muscles, tendons, and ligaments. With repetitive motions and awkward postures, the tissues surrounding nerves become swollen, and squeeze or compress nerves (Fig. 7).

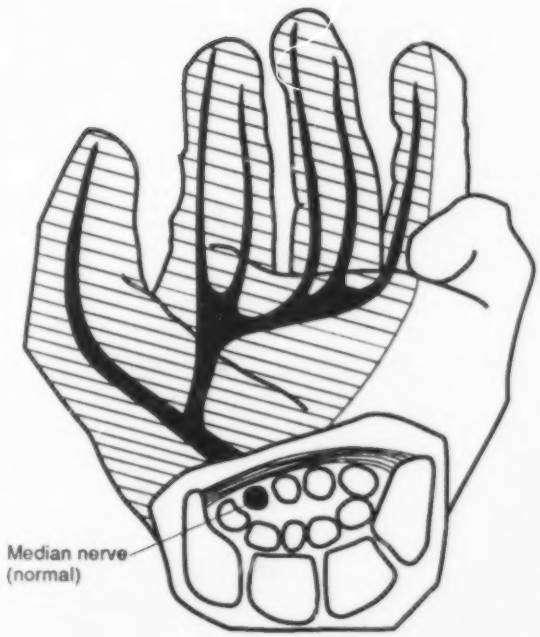


Figure 7a - **Wrist in natural condition**

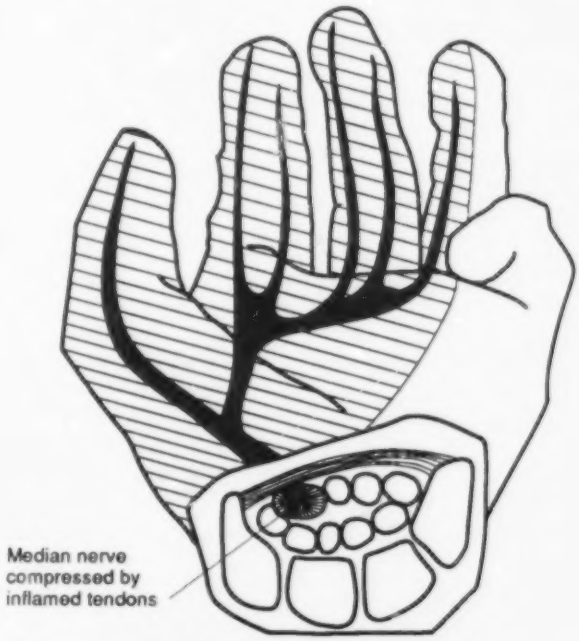


Figure 7b - **Wrist showing symptoms of carpal tunnel syndrome**

Compression of a nerve causes muscle weakness, sensations of "pins and needles" and numbness. Dryness of skin, and poor circulation to the extremities, may also occur.

6. WHAT ARE THE SYMPTOMS OF REPETITIVE MOTION INJURIES?

Pain is the most common symptom associated with repetitive motion injuries. In some cases there may be joint stiffness, muscle tightness, redness and swelling of the affected area. Some workers may also experience sensations of "pins and needles," numbness, skin colour changes, and decreased sweating of the hands.

Repetitive motion injuries may progress in stages from mild to severe.

Early stage: Aching and tiredness of the affected limb occur during the work shift but disappear at night and during days off work.

No reduction of work performance.

Intermediate stage: Aching and tiredness occur early in the work shift and persist at night.

Reduced capacity for repetitive work.

Late stage: Aching, fatigue, and weakness persist at rest.

Inability to sleep and to perform light duties.

Not everyone goes through these stages in the same way. In fact, it may be difficult to say exactly when one stage ends and the next begins. The first pain is a signal that the muscles and tendons should rest and recover. Otherwise, an injury can become longstanding, and sometimes, irreversible. The earlier people recognize symptoms, the quicker they should respond to them.

Table 2 outlines occupational risk factors and symptoms of the most common disorders of the upper body associated with repetitive motion injuries.

Table 2 - **Identified disorders, occupational risk factors and symptoms**

Disorders	Occupational Risk Factors	Symptoms
Tendonitis/Tenosynovitis	Repetitive wrist motions Repetitive shoulder motions Sustained hyperextension of arms Prolonged load on shoulders	Pain, weakness, swelling, burning sensation or dull ache over affected area
Epicondylitis (Elbow Tendonitis)	Repeated or forceful rotation of the forearm and bending of the wrist at the same time	Same symptoms as tendonitis
Carpal Tunnel Syndrome	Repetitive wrist motions	Pain, numbness, tingling, burning sensations, wasting of muscles at base of thumb, dry palm
DeQuervain's Disease	Repetitive hand twisting and forceful gripping	Pain at the base of the thumb
Thoracic Outlet Syndrome	Prolonged shoulder flexion Extending arms above shoulder height Carrying loads on the shoulder	Pain, numbness, swelling of the hands
Tension Neck Syndrome	Prolonged restricted posture	Pain

7. HOW ARE REPETITIVE MOTION INJURIES RECOGNIZED?

The evaluation of repetitive motion injuries includes identifying workplace risks. Evaluation begins with a discussion of the person's employment and requires a detailed description of all the processes involved in a typical workday. Consideration is given to the frequency, intensity, duration, and regularity of each task performed at work.

Diagnosis of repetitive motion injuries is confirmed by performing laboratory and electronic tests that determine nerve or muscle damage. One such test, electroneuromyography (ENMG), encompasses two areas: electromyography (EMG) and nerve conduction velocity (NCV). Magnetic resonance imaging (MRI), an alternative to x-rays, provides images of tendons, ligaments, and muscles and improves the quality of the diagnostic information

8. HOW ARE REPETITIVE MOTION INJURIES TREATED?

The treatment of repetitive motion injuries involves several approaches including the following:

- Restriction of movement
- Application of heat or cold
- Exercise
- Medication and surgery

Restriction of Movement

The first approach to treatment of repetitive motion injuries is to avoid the activities causing the injury. This often requires work restrictions. In some cases, transfer to a different job should be considered. A splint can also be used to restrict movements or to immobilize the injured joint. However, the use of splints in occupational situations requires extreme caution. If used inappropriately, splints can cause more damage than good. Splints are usually used for two reasons: to mechanically support a joint where an excessive load on the joint is anticipated, or to restrict the movement of the injured joint.

In the occupational context, splints should not be used as a mechanical support for the joint. Instead, the job should be redesigned to avoid the extreme load on the worker's joint in the first place.

To be effective, the use of splints to immobilize an injured joint also requires that the work activity that caused the injury be stopped or changed. If injurious work continues, then the worker is exposed to risk of injury to other joints that have to compensate for the one that is splinted.

Application of Heat or Cold

Applying heat or cold seems to relieve pain and may accelerate the repair process. Heat is recommended for pain relief of minor injuries. It is not recommended for injuries with significant inflammation and swelling.

Heat increases the flow of blood and increases swelling. Ice reduces pain and swelling.

Exercise

Stretching is beneficial because it promotes circulation and reduces muscle tension. However, people suffering from repetitive motion injuries should consult a physical therapist before exercising. Stretching or exercise programs can aggravate the existing condition if not properly designed.

Medication and Surgery

Aspirin, non-steroidal anti-inflammatory drugs, and injected costicosteroids can reduce pain and inflammation. The doctor may try more elaborate treatments or even surgery if all other approaches fail.

9. HOW CAN WE PREVENT REPETITIVE MOTION INJURIES?

Hazards are best eliminated at the source; this is a fundamental principle of occupational health and safety. In the case of repetitive motion injuries, the prime source of hazard is the repetitiveness of work. Other components of work such as the applied force, fixed body positions, and the pace of work are also contributing factors to RMI. Therefore the main effort to protect workers from RMI should focus on avoiding repetitive patterns of work through job design which may include mechanization, job rotation, job enlargement and enrichment or teamwork. Where elimination of the repetitive patterns of work is not practical, prevention strategies involving workplace layout, tool and equipment design, and work practices should be considered.

Job Design

Mechanization

One way to eliminate repetitive tasks is to mechanize the job. Where mechanization is not feasible or appropriate, other alternatives are available.

Job Rotation

Job rotation is one possible approach. It requires workers to move between different tasks, at fixed or irregular periods of time. But it must be a rotation where workers do something completely different. Different tasks must engage different muscle groups in order to allow recovery for those already strained.

However, job rotation alone will not be effective in reducing RMI if not combined with the proper design of workstations. And it will not be effective while the high pace of work persists.

Job Enlargement and Enrichment

Another approach is job enlargement. This increases the variety of tasks built into the job. It breaks the monotony of the job and avoids overloading one part of the body. Job enrichment involves more autonomy and control for the worker.

Team Work

Team work can provide greater variety and more evenly distributed muscular work. The whole team is involved in the planning and allocation of the work. Each team member carries out a set of operations to complete the whole product, allowing the worker to alternate between tasks, hence reducing the risk of RMI.

Workplace Design

The guiding principle in workplace design is to fit the workplace to the worker. Evaluation of the workplace can identify the source or sources of RMI. Proper design of the workstation decreases the effort required of the worker to maintain a working position. Ideally, the workstation should be fully adjustable, providing a worker with the options to work in standing, sitting or sitting-standing positions, as well as fitting the worker's body size and shape. Detailed information about proper workplace design can be found in the CCOHS publications "Working in a Standing Position" (P88-14E) and "Working in a Sitting Position"(P89-8E).

Tools and Equipment Design

Proper design of tools and equipment significantly decreases the force needed to complete the task.

Providing the worker with the proper jigs or fixtures for tasks that require holding elements saves a lot of muscular effort in awkward positions. For proper design of tools refer to Section 8 of the CCOHS publication: "Ergonomics, a BasicGuide" (P89-20E).

Good tools, maintained carefully and where necessary frequently changed, can also save a lot of muscle Strain.

Work Practices

A well-designed job, supported by a well-designed workplace and proper tools, allows the worker to avoid unnecessary motion of the neck, shoulders and upper limbs. However, the actual performance of the tasks depends on individuals.

Training should be provided for workers who are involved in jobs that include repetitive tasks. Workers need to know how to adjust workstations to fit the tasks and their individual needs. Training should also emphasize the importance of rest periods and teach how to take advantage of short periods of time between tasks to relax the muscles, and how to consciously control muscle tension throughout the whole work shift.

10. CONCLUSION

Work-related disorders of muscles, tendons and nerves are a major cause of lost work in many labour-intensive industries. Occupational risk factors include continual repetition of movements, fixed body positions, forces concentrated on small parts of the body, and lack of sufficient rest between tasks.

Prevention must aim at eliminating the repetitiveness of the work by proper job design. Where this is not possible, preventive strategies such as good workplace layout, tool and equipment design, and proper work practices should be considered. Early recognition of these

disorders is very important because medical treatments are unlikely to be effective once these injuries become longstanding.

Preventive and control measures, in order to be truly effective, require significant involvement on the part of the workers, their representatives, and management to improve occupational health and safety.

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